Evaluation of
Non-Intrusive Technologies
for Traffic Detection

Erik Minge
SRF Consulting Group
NATMEC 2002

Presentation Outline

- Background
- Test Site
- Test Methodology
- Vendors and Technologies
- Test Results
  - Qualitative Issues
  - Preliminary Field Results
- Future Test Activities

Definition of Non-Intrusive Technologies

- Easily deployed without disruption of traffic flow
- Safer for staff to deploy
- Sidefire, Overhead or under pavement

Rapid Deployment

Unique Applications

Background

- FHWA & Mn/DOT sponsored test of Non-Intrusive Technologies for traffic detection
  - Hughes Test: 1992 - 1994
  - NIT Phase I: 1995 – 1997
  - Report is available at

    www.dot.state.mn.us/guidestar
- Success of initial test led FHWA to fund Phase II

Schedule Overview

• Constructed Shelter	April 2001
• Installed Sensors	Summer 2001
• Freeway Testing	Fall / Winter 2001
• Intersection Testing	March 2002
• Final Report	June 2002
• Bike/Ped Testing	Summer 2002

Test Goals

- Evaluate full capabilities and limitations of devices
- Test in varying weather and traffic conditions
- Test in varying mounting conditions (overhead/sidefire, heights, offsets)
- Historical and Real-time/ITS applications

Test Site - NIT Shelter

NIT Shelter - Outside

NIT Shelter - Inside

Test Site - Freeway

- I-394 at Penn Avenue
  - Free flow to heavy congestion
  - Inductive loops in place
  - Three mainline lanes
  - Two reversible HOV lanes
  - Catwalk and adjustable mounting poles
  - Crank-up pole for “side fire” devices

Sidefire Tower

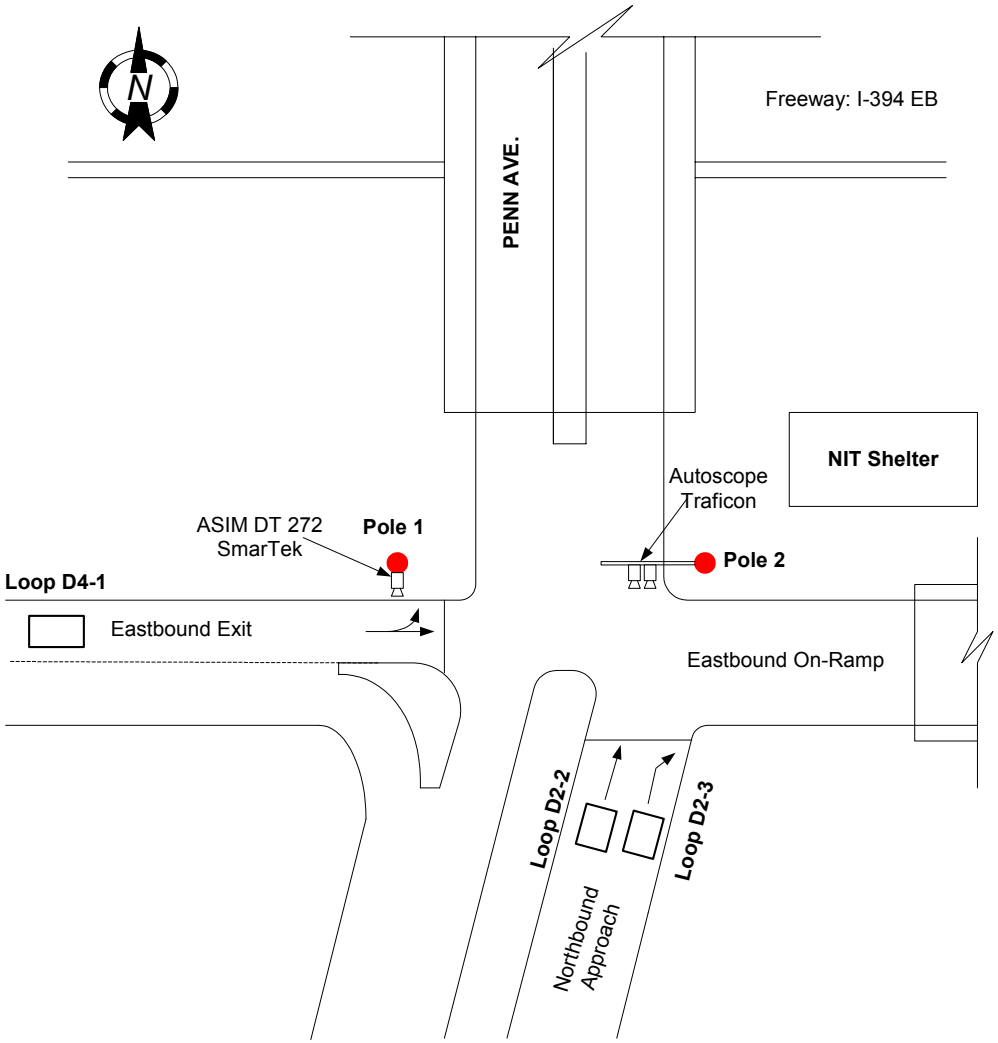
Sidefire Tower

Overhead Mounting Structure

Test Site - Intersection

- I-394 at Penn Avenue
  - Multiple lane and single lane approaches
  - Congested in peak periods
  - Utilize existing loops and poles

Intersection Site



Test Methodology

- Volume, speed, occupancy, presence, classification
- Compare to baseline
- Different test conditions
  - Mounting location
  - Traffic levels
- 24-hour test periods

Technology Groups

- Passive Infrared
- Active Infrared
- Magnetic
- Radar
- Doppler Microwave
- Pulse Ultrasonic
- Passive Acoustic
- Video

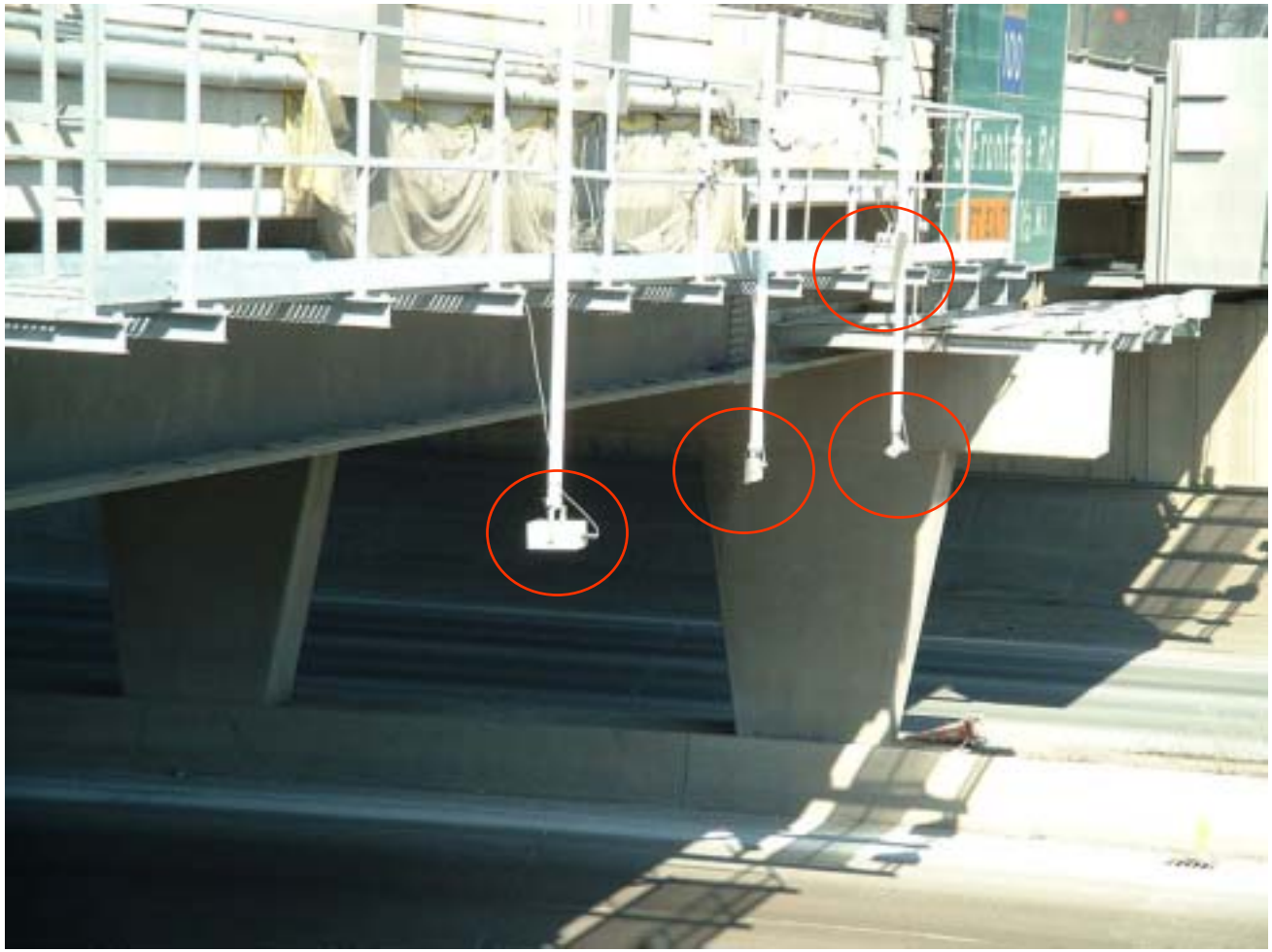
Participating Vendors

- Schwartz Electro-Optics (active infrared)
- 3M (magnetic)
- ECM (microwave)
- SmarTek (passive acoustic)
- Image Sensing Systems (video)
- Traficon (video)

Participating Vendors (continued)

- Novax (ultrasonic)
- ASIM
  - Passive Infrared
  - Passive Infrared/ Ultrasonic
  - Passive Infrared/Ultrasonic/Microwave

ASIM, Schwartz



Video Detectors

Vendor Considerations

- International vs. National vs. Local Presence
- Level of Support Provided
  - Wholesaler Only
  - Integration Support
- Support track record
  - History with large deployments?
  - Responsive to customer needs?
  - How long in market?
  - References available?

Vendor Support

- Schwartz ★★★★
- 3M ★★★★
- ECM ★★★
- SmarTek ★★★★
- Autoscope ★★★★
- Traficon ★★★
- Novax ★★
- ASIM ★★★

Ease of Installation/Calibration

- Schwartz ★★★★
- 3M ★★
- ECM ★★★
- SmarTek ★★★★★
- Autoscope ★★★
- Traficon ★★★
- Novax N/A
- ASIM ★★★

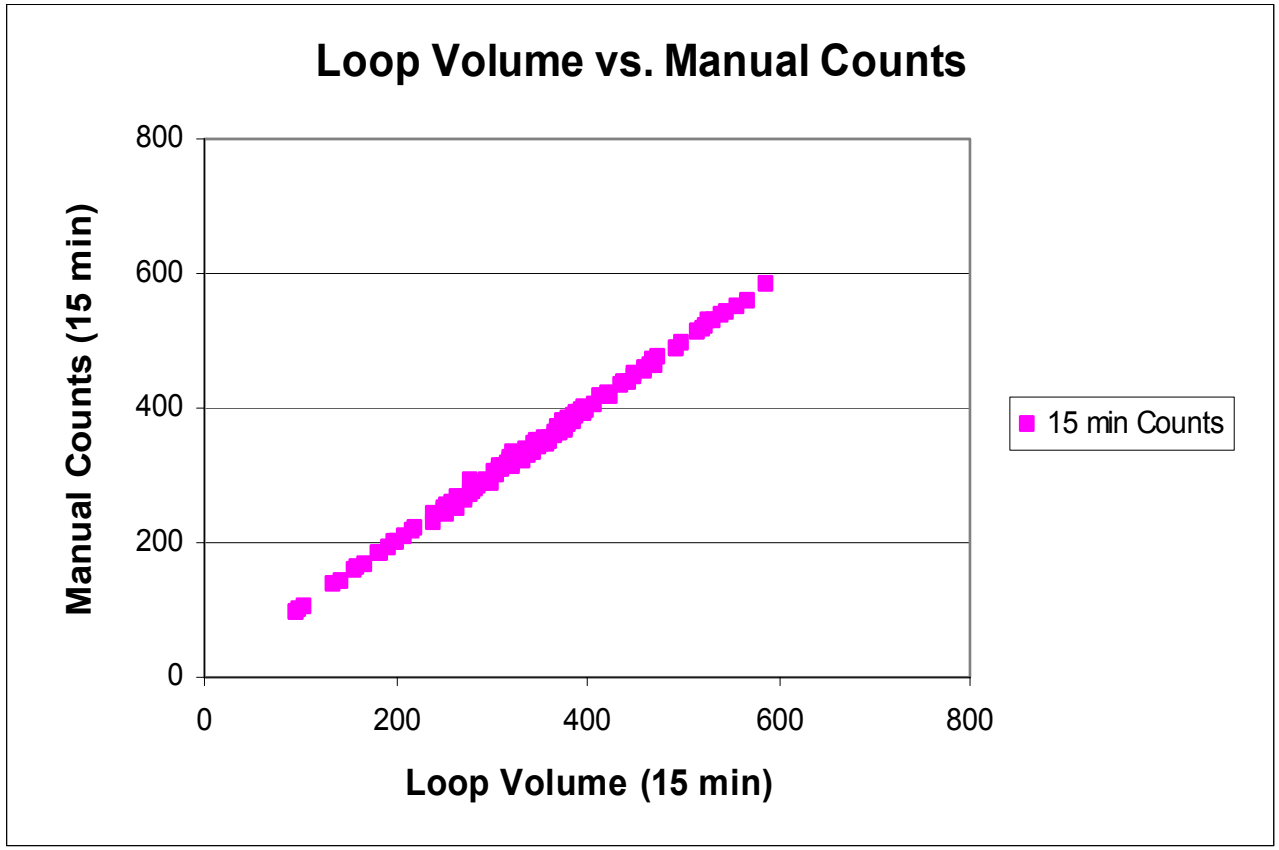
Freeway Baseline

- Manual count of videotape for groundtruth
  - 4-hours of tape (am peak, midday, pm peak, evening)
  - Count tape multiple times
- Freeway results indicate absolute error of less than 2 percent

Freeway Baseline

Date	Lane	Loop Volume	Manual Volume	Percent Difference
Sep 01	1	5436	5368	1.25%
	2	4881	4869	0.25%
	3	5371	5372	1.28%
Nov 01	1	5715	5579	2.38%
	2	5644	5645	0.37%
	3	6611	6545	1.00%
Jan 02	1	5765	5669	1.67%
	2	5111	5097	0.27%
	3	5481	5451	0.55%

Freeway Baseline



Intersection Baseline

Date	Lane	Loop Volume	Manual Volume	Percent Difference
March 02	NB RT	1149	1347	17%
	NB TH	555	564	2%
	EB Exit*	795	505	29%

***Not used**

Overview Results - Freeway

Sensor	Mounting	No. of Lane	Freeway	
			Volume	Speed
ASIM – Passive IR	OH/SF	1	2%	11%
ASIM – Passive IR/ Ult	OH/SF	1	9%	-
ASIM – IR/Radar/ Ult	OH	1	3%	4%
Schwartz - Active IR	OH	1	1%	6%
Autoscope – Video	OH/SF	3	1 - 2%	1 - 3%
Traficon – Video	OH/SF	3	2 - 4%	4 - 8%
SmarTek – P. Acoustic	SF	3	5 - 11%	6 - 8%
3M - Mahnetic	Under	3	2 – 3%	2 - 6%

Overview Results - Intersection

Sensor	Mounting	No. of Lane	Intersection	
			Volume	Presence
ASIM – Passive IR/ Ult	SF	1	-	0%
Autoscope – Video	OH	1	19%	0%
Traficon – Video	OH	1	12%	0 – 20%
SmarTek – P. Acoustic	SF	1	-	0%

Mounting Impact on Sensor Performance

- Two sensors tested at all mounting heights
- 3 Bases, 5 Heights, 3 Lanes
- Results Presentation

  Base vs. height and lane

  Lane vs. height and base

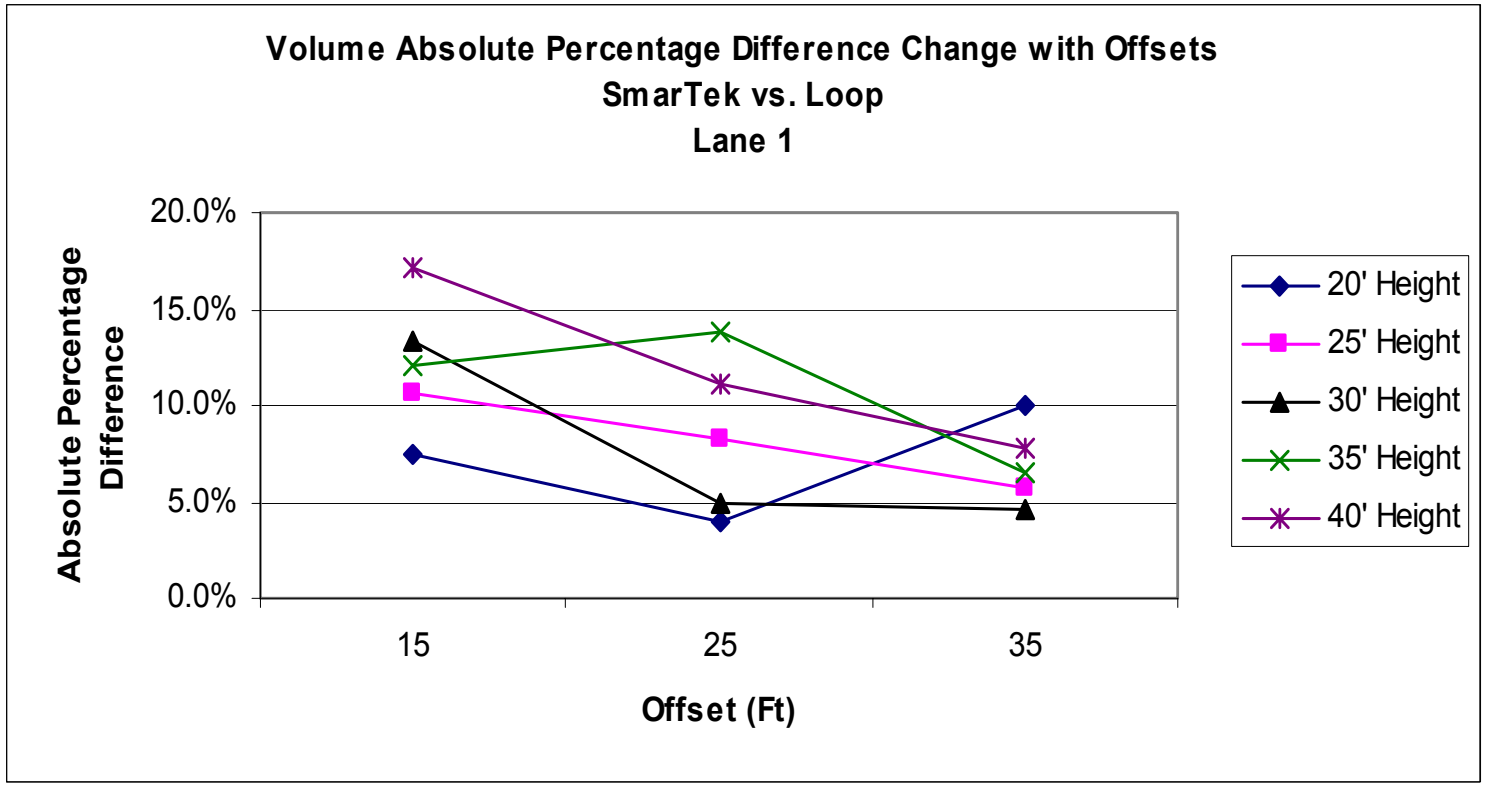
  Height vs. base and lane

Field Test Results

- Video performs better when:
  - Higher
  - Closer to freeway
- Passive Acoustic performs better when:
  - 45-degree angle between traffic and sensor

Preliminary Results (Con.)

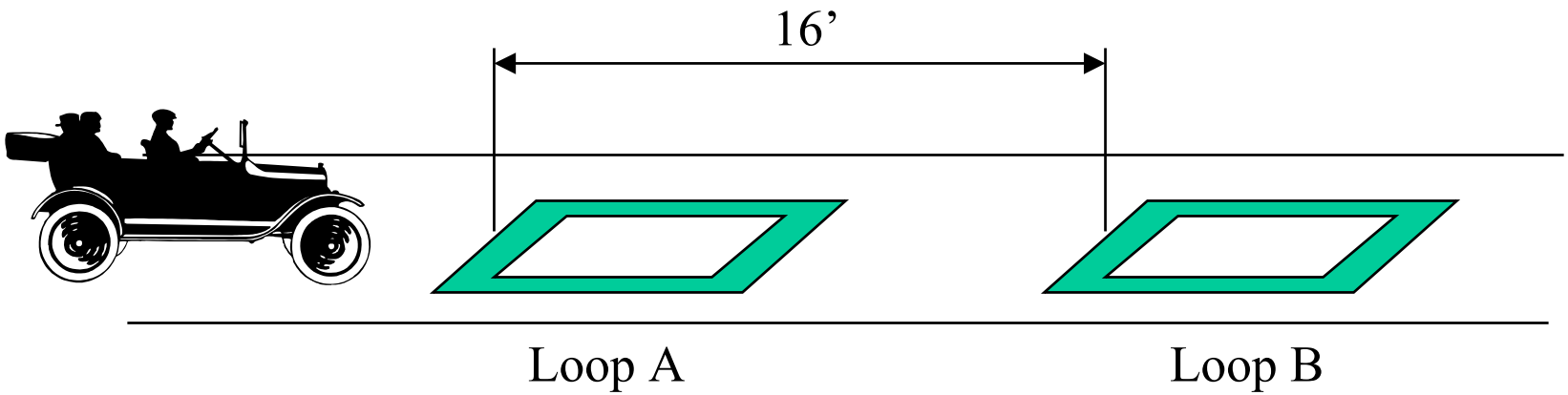
Each Lane: Performance vs. height and base

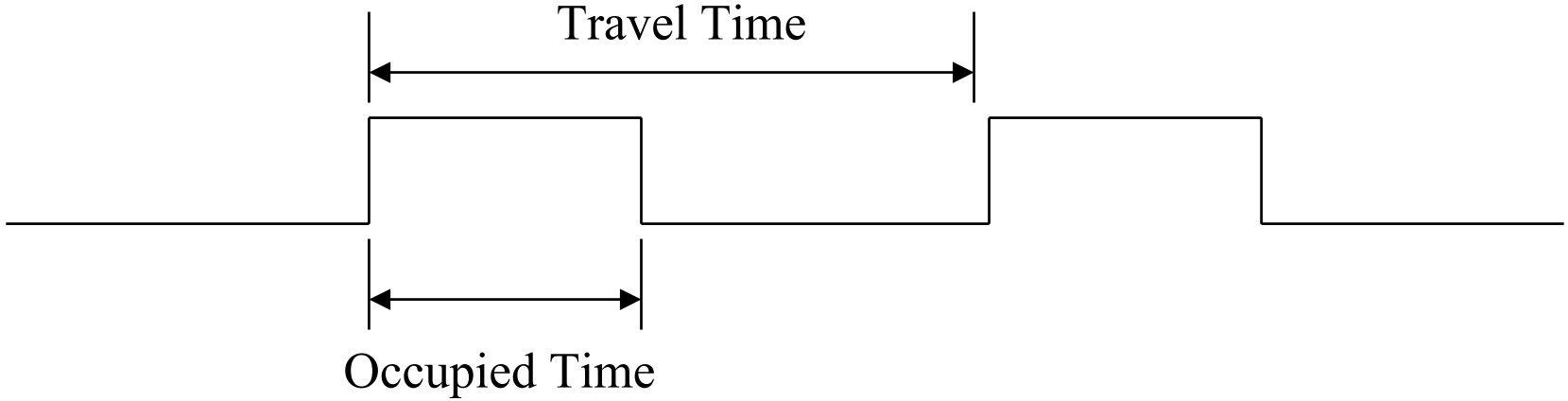


Real-time Data

- ITS/Real Time Applications
  - Lane occupancy
  - Speed
  - Presence
  - Classification (length and height)
- Data Acquisition System Records
  - Occupied time
  - Speed

Loop Detection Schematic

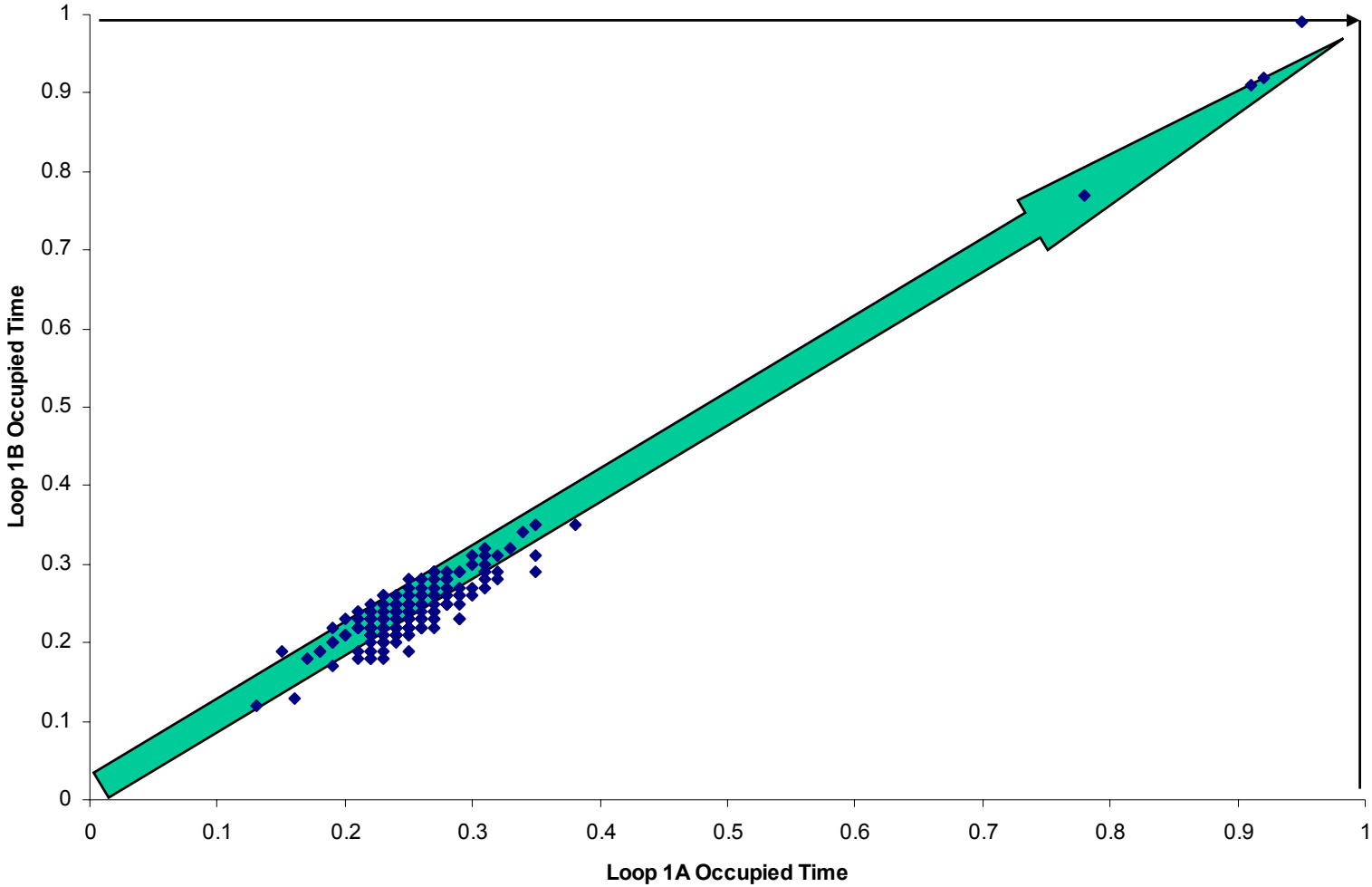




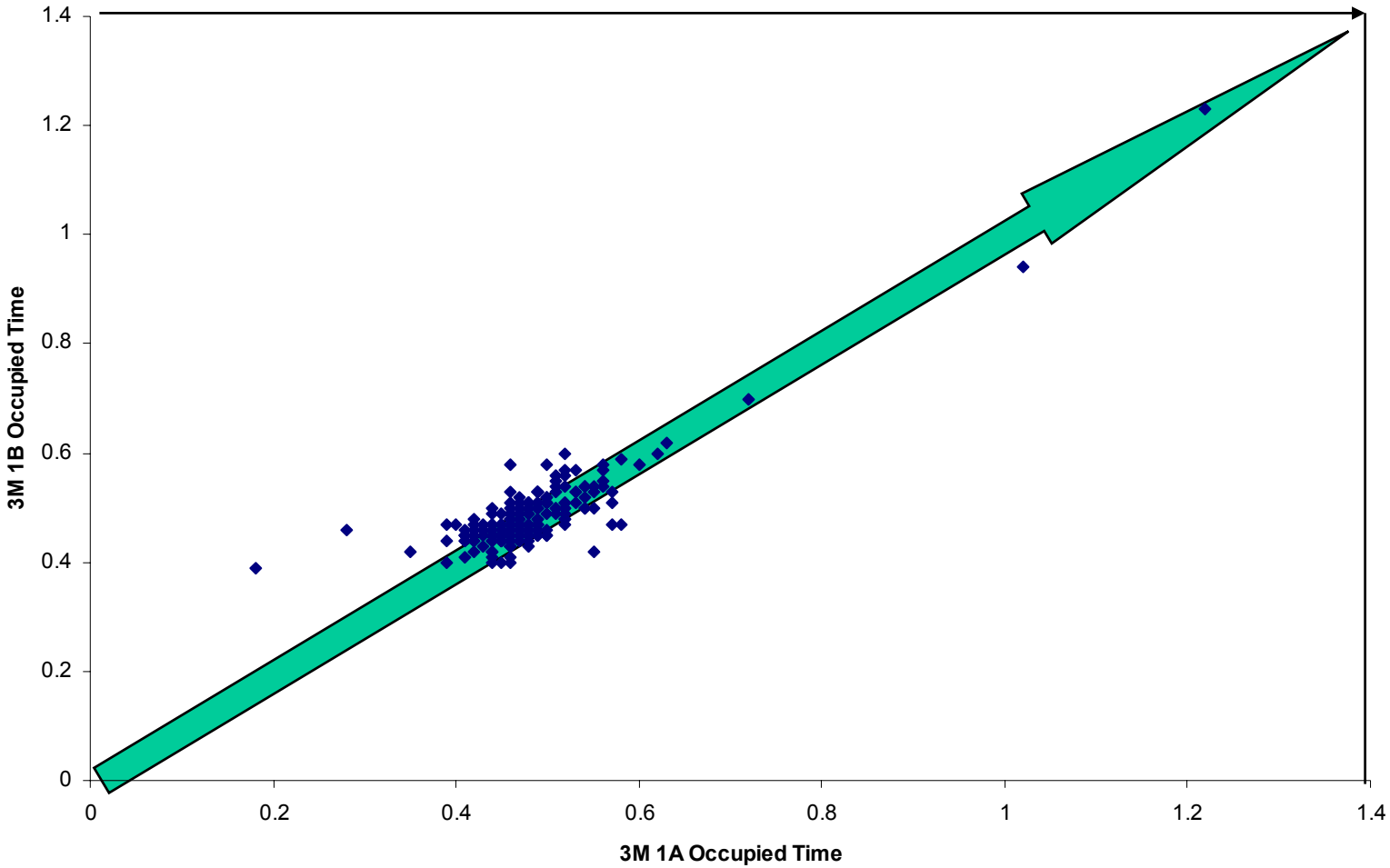
Real-time Data Results

- Data acquisition timing accuracy approximately 1/100th Second
- Observed Occupied Time accuracy
  - Loop 0.26 vs. 0.25 sec 7.0% abs error

Loop 1 Occupied Time Check



3M 1 Occupied Time



Phase I Results Review (Weather)

- Most devices performed well in varying weather conditions
- Video devices affected by wind and lighting conditions
- Snow caused poor vehicle tracking

General Results

- Most devices suited to temporary applications
- Performance varies little from technology to technology
- Heavy traffic had some impact at freeway
- Intersection counting not as accurate
- Factors to consider
  - Ease of installation,calibration and maintenance
  - Mounting flexibility
  - Power supply needs
  - Amount of vendor support

Next Test: Bike/Ped Detection

- Developed Test Plan
  - Literature Review
  - Detection Applications
    - Curbside/Crosswalk Ped Detection (Intersection)
    - Intersection Bicycle Approach
    - Historical Data (Trail)
  - Parameters: presence, volume, speed, direction

Pedestrian Detection

Pedestrian Detection

Future Test Activities

- **Guidance – Technical Working Group**
  - Formed 1997
  - Met at NATMEC 2000
  - And NATMEC 2002 (5 to 6pm in Salon 5)
  - Provide feedback on useful research
  - Created Standard Test Methods

Research Needs

- Automatic Vehicle Identification?
  - Travel Time Data
  - Origin-Destination Studies
- Sensor Certification?
- Traveling Demonstration
- Bike/Ped/Train Detection?
- Practical, Responsive

Thank you

For more information

projects.dot.state.mn.us/nit

www.dot.state.mn.us/guidestar

farideh.amiri@dot.state.mn.us

eminge@srfconsulting.com